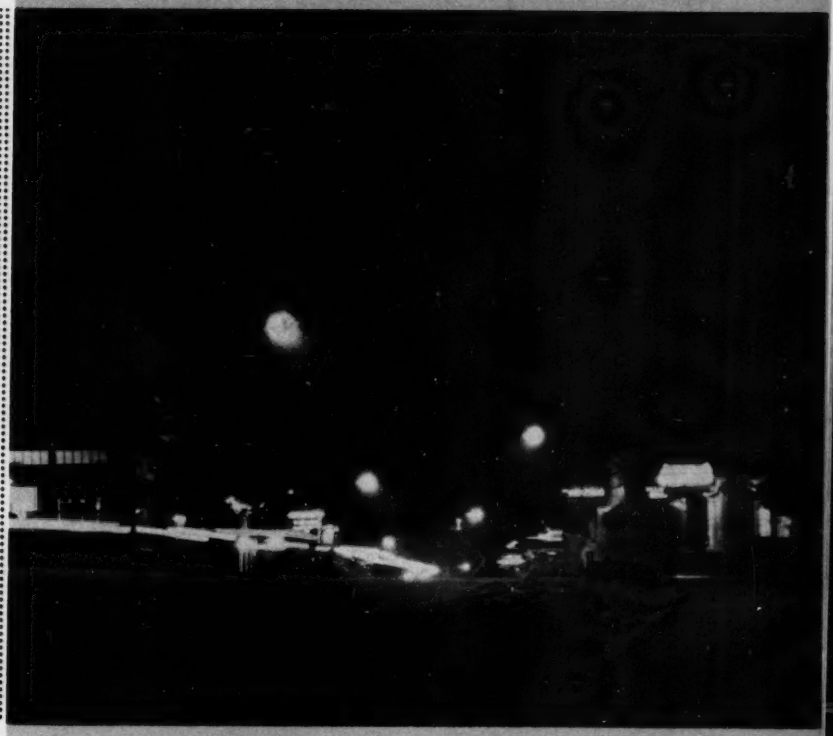
COLLEGE OF ENGINEERING CORNELL UNIVERSITY

The Cornell engineer



JANUARY, 1952

VOL. 17, NO. 4

25 CENTS

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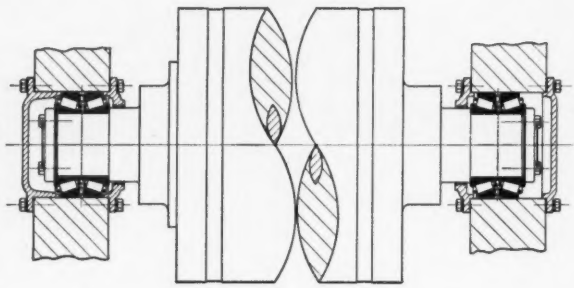

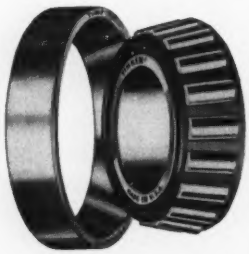

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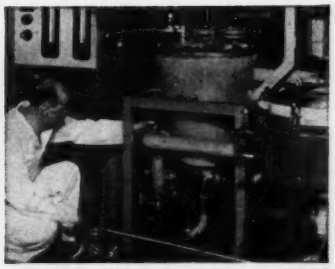
THE DU PONT DIGEST



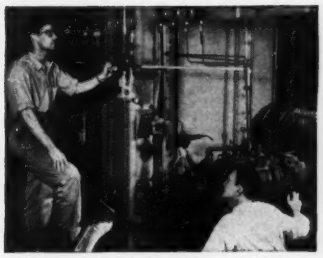
CHEMICAL *engineers supervise preparation of larger-than-laboratory batches of chemicals in Du Pont's Special Service Laboratory.*

Ch. E's at Du Pont

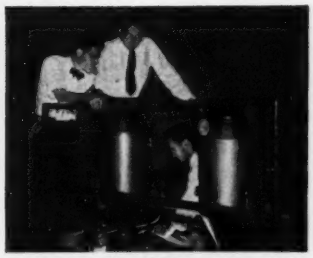
[FIRST OF A SERIES]

New products mean new opportunities for chemical engineers

STUDYING *"Teflon" tetrafluoroethylene resin insulating material with special apparatus: K. F. Richards, B.S.Ch.E., Cornell '48; and E. K. Holden, M.S.Ch.E., Delaware '48.*



CHECKING *a multi-stage carbon-monoxide compressor used in semi-works operations: R. L. Stearns, B.S.Ch.E., Yale '49; and H. Peterson, B.S.Ch.E., Northeastern University '42.*



CHARGING *experimental polymers to spinning machine: O. C. Wetmore, Ph.D.Phys.Ch., New York U. '44; D. A. Smith, B.S.M.E., Purdue '40; and C. O. King, Sc.D.Ch.E., Michigan '43.*

To you as a student chemical engineer, what does this statement bring to mind:

> **Nearly two-thirds of Du Pont's current sales are in products entirely or virtually unknown in 1930.**

Likely it suggests years of solving intriguing engineering problems, the designing of unique equipment, the carrying out of reactions under extraordinary conditions.

But it should also suggest the opportunities that will come to chemical engineers in the future. For at Du Pont, new and better products are continually being developed. From today's extended program of fundamental research you can expect more neoprenes, more nylons, more plastics like "Teflon" tetrafluoroethylene resin.

As these products come out of the laboratory, they will bring with them a succession of interesting and challenging problems for the chemical engineer. Problems that will arise out of their very newness.

For instance, take nylon, the first wholly synthetic organic fiber. In working out techniques for its commercial manufacture, there was practically nothing to go on. The compounds of which it was made, hexamethylenediamine and adipic acid, were essentially laboratory chemicals. Processes had to be devised to make them from cheap raw materials—benzene, hydrogen, air and ammonia. Large-scale preparation of nylon salt from amine and acid required going beyond the classical unit operations.

Here for the first time it was proposed to extrude a fiber with extreme accuracy from a melted polymer at 290°C. At this temperature the polymer decomposes slowly. It had to be melted, pumped at 5000 p.s.i. pressure through microscopic holes and cooled in a hurry. Otherwise the fiber would emerge discolored.

The Du Pont chemical and mechanical engineers and other men and women who worked with them ran into one difficulty after another. More than once they thought that the project would have to be abandoned.

However, it is basic in Du Pont people's philosophy not only to take on difficult pioneering problems, but to see them through. With nylon, this persistence paid off handsomely.

Is this the kind of problem *you'd* like to attack, the kind of people *you'd* like to work with?

NEXT MONTH — Opportunities for chemical engineers in research and development will be discussed in the second article in this series. Watch for it!

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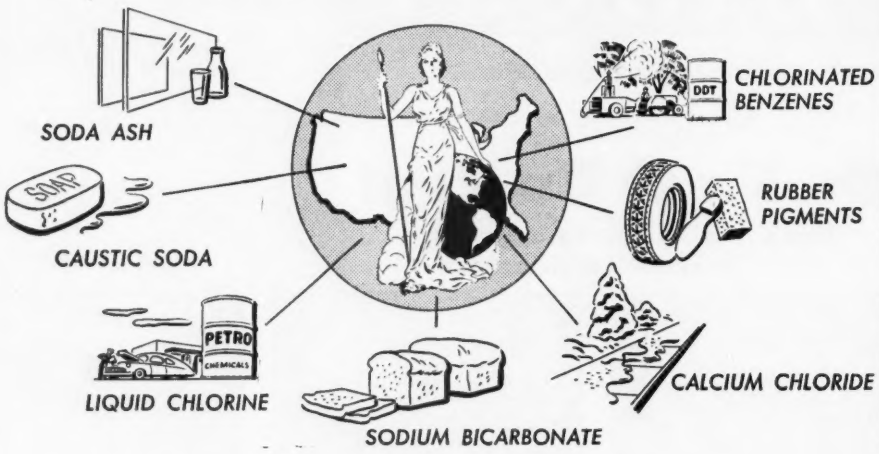

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College Faculty Members: While diminishing enrollment in Chemical Engineering promises greater opportunity to the student, it leads in turn to a potentially critical manpower shortage of trained chemical technicians.

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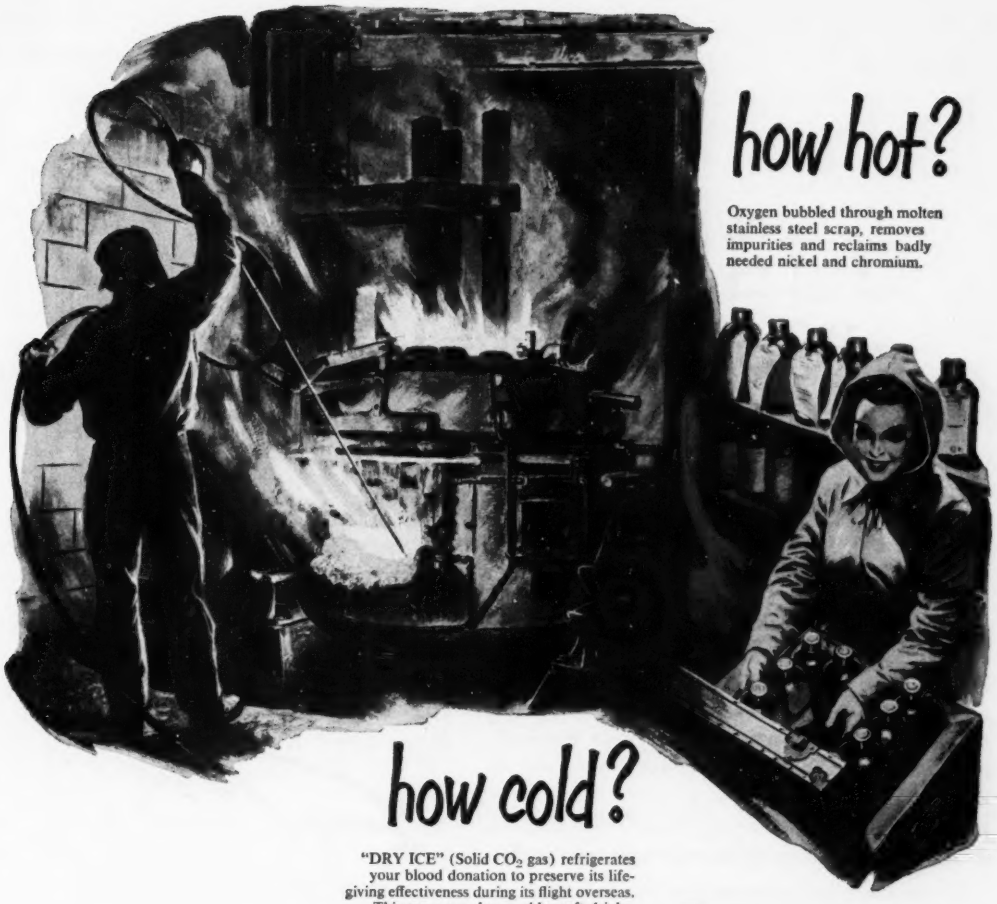

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What decides wages?

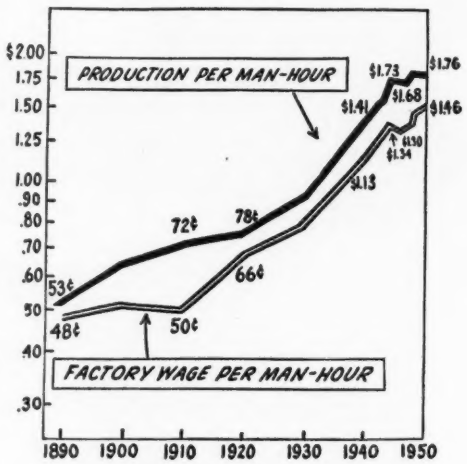
What you and I produce

THERE IS ONE RULE OF NATURE that all the governments, laws, unions and contracts cannot change: a man can be paid *only* out of what he produces, and the more he produces the more he can earn.

AND, that line "Factory wage per man-hour," shown in the chart at right, has gone up and up only as American business has put better and better *machines* to team up with American workers. *Machines* help the worker produce more and so earn more.

And *machines* can come only from the savings of investors—the savings made out of investor profits.

So—profits plus machines plus workers who use them well, equal constantly rising savings and standard of living. Whoever attacks *profits* is attacking *you,* and your family. Never forget it.



Production per man-hour represents the total national income produced per man-hour worked by all employed persons. Factory wage represents average hourly earnings of factory workers. All figures are in dollars of 1950 buying power to eliminate price changes, and show real purchasing power.

Source: Labor's Monthly Survey, American Federation of Labor.

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—*Rosenthal*

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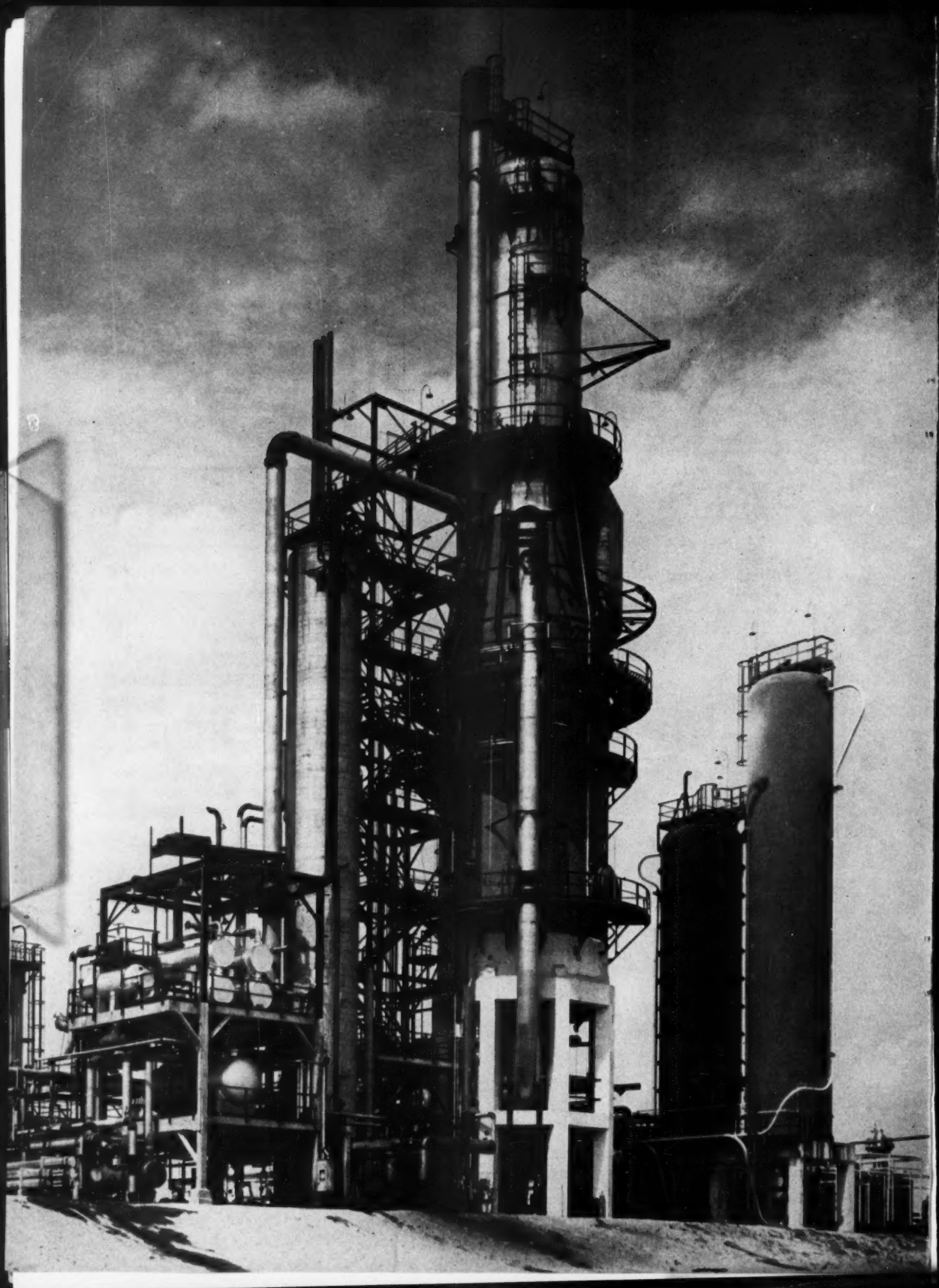


Progress In Petroleum

By PROF. HERBERT F. WIEGANDT

A Brief Analysis of One of The Nation's Largest Industries

Large-scale operations, continued growth, and progressive technology have been characteristic of the petroleum industry since early in the century. Of the fifteen largest manufacturing companies in the country, as measured by total assets, how many of them have been petroleum companies?

1900	none
1910	1
1920	4
1930	7
1940	7
1949	8

In 1949 we consumed over 2.2 billion barrels of petroleum. In the face of operations of this magnitude it becomes of immediate interest to consider where this oil is coming from and how long it will last. The exhaustion of our petroleum resources within a twenty or thirty-year period has been predicted in numerous published articles for the past twenty-five years. Even the more optimistic argue logically enough that though we continue to uncover new reserves, they merely extend our peroid of grace, for ultimately there must come an end to these discoveries. Unfortunately, there have been occasions when technically-trained men hesitated entering the petroleum industry because of its limited future. Actually, for many years this industry will continue to improve quality, techniques, and yields as well as to introduce new products. When finally limitations in petroleum supplies are felt, the demands for scientists and engineers must be greater than ever because of the added complexities of converting natural gas, shale, tar sands, and coal to the desired liquid hydrocarbons.

A small stacked catalytic cracking unit built by Foster Wheeler for a refinery. This 7,000 bpd unit has the reactor placed over the regenerator, instead of side-by-side.

Petroleum Resources

Some misconception can arise from the fact that the United States has consistently produced from one-half to two-thirds of the world's petroleum. The reason for this is principally that we have a high per capita utilization of petroleum products; and the trend continues upward. Although until the past few years we have had a net exportation of petroleum, largely in the form of refined products, it has been less than seven per cent of our own consumption. Today the balance is favored by a net import balance of several per cent. Most of the oil leaving the Western Hemisphere has originated in Venezuela. Because of the intensive development within the United States, there is infinitely more known about the reserves here than those of any other area of the world, but still major revisions of proved reserves occur year after year. Thus, our high production and proved-reserve figures mean neither that we have an unusually favorable status with respect to petroleum as a natural resource, nor that we have generally supplied the demands of the remainder of the world. Also, if so much remains to be learned about deposits in the highly-explored United States, then estimates of the world's reserves are little more than wild speculation. World reserves should simply be considered in a more optimistic light than was even dreamed of a few years ago.

The principal petroleum provinces include: the Mediterranean region, a great area of once-submerged land which includes the tremendous oil fields of the Middle East; the basin occupied by the Gulf of Mexico and the Caribbean sea; the shallow basin including Java, Sumatra, and Borneo between Asia and Australia; and the Arctic region including Northwest Canada. Actually most oil has come from what geologically would be considered minor basins; the oil fields of California, the interior basins of the Mississippi Valley, Bolivia and Argentina, and the margin of the Baltic Sea. Since most of the smaller basins outside of the United States have been little explored, they have contributed little petroleum, but there is no reason to think that ultimately they will be less rewarding.

As the petroleum industry expanded, the distribution of products as well as the methods of their manufacture were greatly modified, but by no means in a parallel fashion. Before World War I the major product was kerosene. Growing automotive requirements, a recognition of the usefulness of liquid fuels, and the electric light resulted in its soon being supplanted by gasoline and fuel oil. Increasing use of jet engines using kerosene as a fuel is re-establishing kerosene as a more important product. Since 1930 the variations in product distribution have not been marked, the fuel oil and gasoline ratios being approximately the same, and the sum of all other products amounting to about fifteen per cent of the total. The flexibility of today's operations would permit the refiner to increase the proportion of

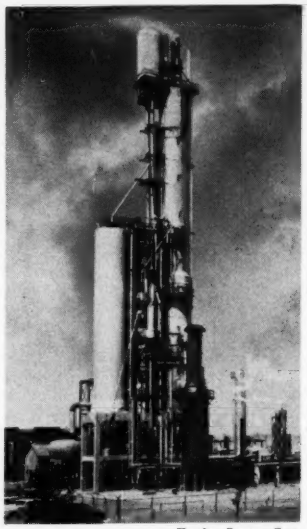
gasoline to seventy per cent, but this comes only with higher operating costs, which are not justified when the loss of the fuel market is considered. On the other hand, transformations in refining methods are taking place constantly, particularly in the manufacture of gasoline and lubricating oil.

Gasoline produced directly as a distillate fraction from crude oil is not a very satisfactory fuel for internal combustion engines. The addition of a gasoline-soluble compound of a heavy metal, such as lead tetraethyl, slows down the rapid chain-reaction of combustion and thereby reduces knocking. However, the inherent deficiencies of this gasoline are too great for its use by itself as a quality fuel.

To improve both the gasoline yield from crude petroleum and its quality it is necessary to reconstruct the molecules. Heavy fractions may be cracked, light ones recombined, and poor quality material already in the gasoline boiling range may simply be reformed. The advantages of creating the right kinds of molecules justify a continuing trend which at the present time has resulted in ordinary motor gasoline containing over sixty per cent of molecules not originally present in the crude petroleum. Although half of this processing is still done by thermal methods, the trend is more and more toward catalytic cracking and catalytic reforming.

Catalytic Cracking

Catalytic cracking has changed the characteristics of motor gasoline completely since it was introduced fifteen years ago. The catalyst, a porous material of very high surface area, does more than merely accelerate the type of reactions experienced with thermal cracking. Instead of merely chopping molecules, catalytic cracking permits chain branching (isomerization) and ring formation (aromatization). These last two reactions contribute much to the anti-knock quality of present-day gasoline. The types of catalytic cracking receiving most attention today depend on a moving catalyst either of a pellet or of the powder variety. Publicity for recent catalytic units has stressed their large size—capacities of over forty thousand barrels per day. A better indication of engineering improvements in the last few years has been the successful construction of many small units which operate competitively with flows of about six thousand barrels per day. This development is of particular value to smaller refiners.



—*Houdry Process Corp.*

A Houdriflow catalytic cracking unit, capacity 11,000 barrels per day.

Most advancements in the design of catalytic cracking units result from an improved application of fundamental engineering principles. As more becomes known about fluid properties of systems containing suspended particles, the designs are altered to provide a simplified flow arrangement. Similarly, the bead type of catalyst is now recirculated in a manner which recognizes the most significant feature of a constriction, such as a Venturi or a laboratory aspirator, in a flow line—that a decrease in pressure results from an increase in flow velocity.

Catalytic Reforming

Just as there are competitive methods of catalytic cracking to make better gasoline from heavy oil, there are alternate methods of reforming from which to choose. Processes which start with ordinary gasoline products containing significant quantities of benzene, toluene, and xylene are of great current interest both from the standpoint of producing an improved fuel and of relieving the shortage of benzene as a raw material for the chemical industry. Much more will be heard about these developments in the next few years.

ABOUT THE AUTHOR

The automobile was already a honking success in all the populated areas of the country, but in the hinterlands of the author's birthplace in Central Michigan the horse had simply assumed the added task of dragging the misguided vehicles from poorly-marked cow trails. Later, the author's enthusiasm for chemistry, undaunted by the failure of his high school to give extra credit for the many unscheduled experiments that never did more than minor damage, was translated into chemical engineering.

By the time he received his Ph. D. from Purdue University in 1941 he had worked in oil refining at Baton Rouge, La., and upon graduation went with Standard Oil Co. of Indiana. From there he went with the Armour Research Foundation before coming to Cornell in 1947. He is now Associate Professor of Chemical Engineering.

One such process results largely from engineering improvements in the established Hydroforming operation. The major modification is that of fluidizing the catalyst to give continuous operation and continuous catalyst regeneration. Another catalytic reforming operation, Platforming, operates at much higher pressures and utilizes a platinized catalyst. Catalyst contamination is sufficiently slow to justify a stationary catalyst. The recovery of individual aromatic compounds from these processes requires expensive auxiliary separation equipment such as extractive distillation or selective absorption apparatus. The quantity of aromatics required to meet the demands of the chemical industry is only a small part of the total to be available from this aviation-quality gasoline. The price will determine how much aromatic material is actually isolated.

Lubricants

After catalytic cracking and reforming for improved fuels, perhaps the greatest refining advances are in the manufacture of improved lubricants. Economically they are of importance because modern lubricants, particularly for internal combustion engines, serve to prolong engine life and improve operation. The duties assigned to these lubricating oils have long been recognized as going far beyond the mere reduction of friction. It is now well established that engine wear is fundamentally a corrosion problem, corrosion resulting from acidic etching by condensed combustion products. Sulfur in the gasoline is responsible for some of the acidity. The harmful effects of this acidity can be reduced by providing lubricating oils with an alkaline reserve and by keeping to a minimum the low-temperature operation of the engine. Most car owners still do not recognize how important their habits are in determining the rate of engine deterioration. Under no conditions should an engine be turned off before it has been thoroughly warmed up.

Nature endowed certain petroleums with remarkable lubricating properties; yet further improvement can be carried out. The lubricating fraction contains wax which in cold weather keeps the oil from flowing. However, wax has desirable lubricating properties at proper operating temperatures. Thus, additives which prevent the growth of large wax crystals are in common use. In most industrial operations an impurity which prevents good crystal growth is objectionable; here it is desired.

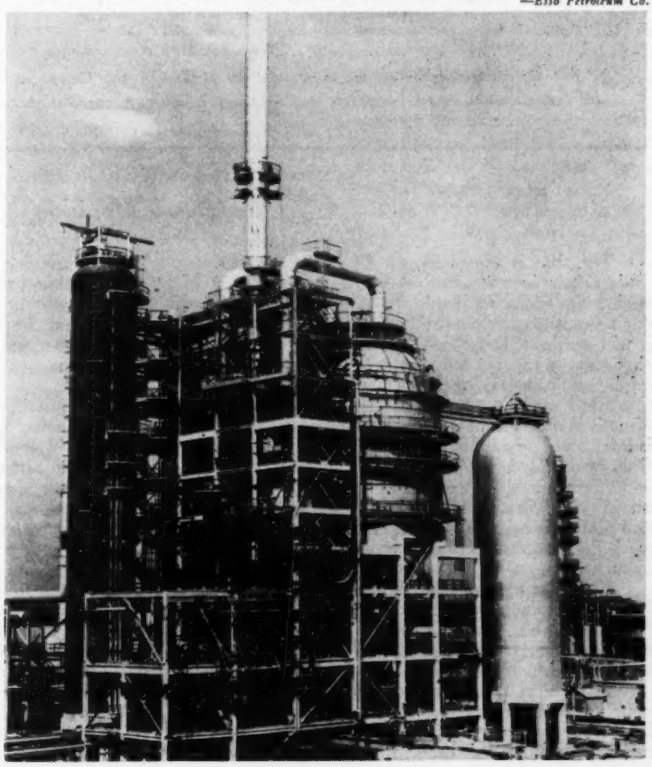
In any lubricating-oil fraction from petroleum, there are some molecules which are more desirable than others. Isolating the desirable molecules into one fraction is one of the difficult refining operations. Separation by ordinary distillation is impossible because poor and good compounds may have identical boiling points. Even with improved extraction techniques and better solvents which today are increasing the sharpness of separation, increasing product quality, and reducing losses of valuable material, some of the beneficial properties of a lubricant are still removed. It is desirable, particularly in the winter, to have a lubricant which flows freely at low temperatures and yet is not too thin at engine operating temperatures. To improve the viscosity - temperature relationship there are in use a number of polymeric compounds which, when present in oil in concentrations of one or two per cent, act as ordinary diluents at low temperatures but as a jumble of expanded molecules at higher temperatures. The internal friction created by these unwieldly constituents counterbalances noticeably the normal decrease in viscosity of oil as its temperature is increased. The non-Newtonian properties of these mixtures make quantitative evaluations of performance difficult and suggest caution in the interpretation of test data obtained with conventional viscometers.

Particularly under stress conditions in an engine is a lubricant subjected to its most grueling test

(*Continued on page 22*)

A nearly completed catalytic cracking unit at Fawley, England. In this refinery, Europe's largest, the "cat cracker" has a regenerator 56 feet in diameter, and the reactor is 35 feet in diameter. Capacity 41,000 bpd.

—Esso Petroleum Co.



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W. R. Sears, Director of the Graduate School of Aeronautical Engineering
L. P. Smith, Director of the Department of Engineering Physics

Frederic C. Wood

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish closer relationship between the college and the alumni."

President's Message

The time is especially good for engineers to appraise their jobs because there is an abundance of engineering jobs available today. The shortage of engineers is no myth and there is every indication that it will continue. Dean Hollister has been trying to get that story across for some time. If you are working at a job you dislike taking advantage of the situation.

Hard work is a term that is often misused. Too often it is used meaning a large quantity of work. This is a fallacy. The quantity of work doesn't make it hard. Only work that is unpleasant, distasteful, unproductive and boring is hard work. Difficult work or a large quantity of work, as long as it is interesting, pleasant and productive, is not *hard* work. If your work is hard work because you don't like your work, do something about it.

Too often a good man becomes stymied in his job. Maybe he is unable to use his full capabilities. Perhaps there are other factors such as nepotism, company politics, changes in ownership or management that have caused him to hate to go to work in the morning.

Perhaps you have made a mistake in selecting your job or even your profession. If you have, admit it. It is a worse mistake to stay in it if you are not fitted for it or are unhappy in it.

Continuing to work daily in a state of unhappiness will do things to you. That's where many of the heart attacks get their beginnings. That is where ulcers are bred, that is where other physical and mental disturbances start.

Perhaps a job change may cause a reduction in income or a loss of seniority or loss of pension rights or group insurance. Don't let those bugaboos deter you. A man unhappy in his job should steadfastly pursue the objective of making a change.

Don't sit back and wait for something better to come along. Many successful people have gone from job to job until they found one that just suited them. Usually it is that kind of a job that brings real success. There is such a place for all of us. It may take a little philosophy and courage to find it.

To help you, there is the Cornell University Placement Services—at Ithaca managed by John Munschauer; at New York by Paul Reyneau, Secretary-Treasurer of the Cornell Society of Engineers, located at 107 East 48th Street, New York 17, N. Y. If you need their help call on them. This is important and timely.

FREDERIC C. WOOD

Alumni News

Frederick Avery, M.E. '09, has retired as assistant chief engineer for Southern Bell Telephone Co. He lives at 51 Peachtree Memorial Drive NW, Atlanta, Ga.

Julian P. Hickok, M.E. '11, retired from teaching last February after teaching mechanical drawing and mathematics for 29 years in Philadelphia public high schools, and returned to the engineering field as a draftsman with the H. L. Yoh Co., Philadelphia, Pa.

Colonel Emerson C. Itschner, C.E. '26, 4456 Fifty-second Avenue, NE, Seattle, Washington, is on his way home from Korea. He supervised the reconstruction of Seoul, Kaesong, and Pyongyang, and was responsible for the construction of more than 300 bridges while First Corps engineer officer with the U.S. Army.

Leonard L. Huttleson, C.E. '26, has been appointed assistant director of New York State parks. He has been with the State park system since 1933. Huttleson lives in Albany.

Joseph S. Thomas, M.E. '27, is director of purchases for Armco Steel Corp. and lives at 311 The Alameda, Middletown, O.

Juan L. Tiongson, M.M.E. '28, has been appointed dean of engineering at the University of the Philippines, Manila.

F. Wells Shoemaker, B.Chem.E. '44, recently admitted to practice as a patent agent, has left the American Enka Corporation to accept the position of head of the Intelligence Section of the Research Department of the Chicopee Manufacturing Company at Chicopee Falls, Massachusetts. Further news is the birth of a son, Ritchie Carr Shoemaker, on July 13.

Howard A. Parker, B.Chem.E. '44, formerly with Standard Oil Co. of Indiana, is technical director at Destrahan refinery of Pan American Southern Corp., Destrahan, Tex.

Lieutenant Prentice Cushing, Jr., USN, B.E.E. '45, and Barbara Jean Pike were married April 14, 1951. Cushing, who has been in the Mediterranean expects to return to Norfolk, Va., in December. His father was **Prentice Cushing '05.**

Bryce MacDonald, B.Chem.E. '45 Manufacturing Engineer for the Waterford Plant of the General Electric Company, reports a daughter born October 13. His home address is 30 Wallace Street, Scotia 2, New York.

Edwin N. Lightfoot, B.Chem.E. '47, is in the research department of Charles Pfizer & Company, Brooklyn, manufacturers of pharmaceuticals.

William F. Kamsler, B.E.E. '49, has left the U. S. Naval Air Development Center to become an electronic instrument engineer for Leeds and Northrup Company. His address is 104 Jericho Manor, Baederwood, Jenkintown, Pennsylvania.

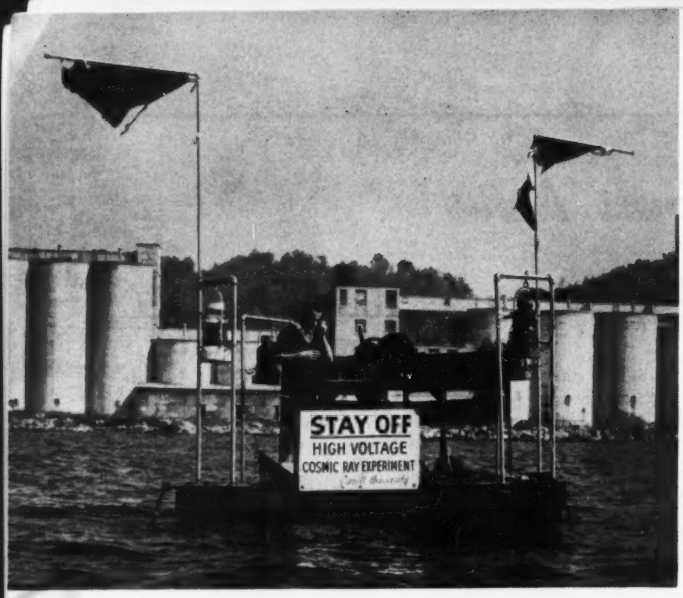
Alvin H. Sacks, M.Aero.E. '49, research scientist at the National Advisory Committee for Aeronautics' Ames Aeronautical Laboratory in California, has been awarded a Fellowship in Aeronautics by the National Research Council. The fellowship, only five of which are awarded throughout the nation, will enable Sacks to spend a year in advanced studies at the Ecole National Superieure d'Aeronautique in Paris.

Sacks received his B.S. in Aeronautical Engineering at the University of Washington in Seattle in 1944 and in 1949 earned his master's degree at Cornell University. He is a member of the Institute of the Aeronautical Sciences and the Society of Sigma Xi. He is now residing with his wife and young son in East Palo Alto, California.

Lou Robinson, B.Chem.E. '50, has been transferred from the Electrochemicals Division of the DuPont Company at Niagara Falls, New York, to the Atomic Energy Division at Dana, Indiana. His home address is 442 N. Center St., Terre Haute, Ind. Lou reports that he was married last summer to Miss Judy Cross of Niagara Falls, Ontario, Can.

J. Dean Gernon, B.Chem.E. '51, is with the National Advisory Committee for Aeronautics. His home address is 16808 LaVerne Avenue, Cleveland 11, Ohio. Gernon was married on July 22 to Miss **Rose Carpenter, '53.**

Aberdeen Proving Grounds in Maryland is the home of four of last year's graduates from the Chem.E. school: **Howard Acheson, Robert Entenman, Stanford Taylor,** and **Donald Victorin.** Entenman's address is Lt. Robert J. Entenman, B.O.Q., "S", Aberdeen Proving Grounds, Maryland. Taylor's is Lt. Stanford H. Taylor, Box 334, Stu. Off Det., Aberdeen Proving Grounds, Maryland.

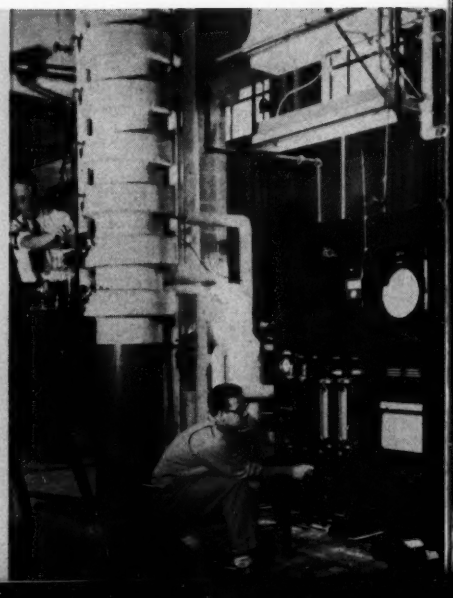


Beneath this float, sensitive Geiger counters detect cosmic rays which hurtle down from outer space and plunge deep beneath the waters of Cayuga Lake.

Research At Cornell

Left: Thirty years a leader in studies of x-ray spectroscopy, Cornell has built numerous devices such as this precision spectrometer. —*Photo Science*

Right: The separation efficiency of a 12" bubble-cap distillation column being tested in Olin Hall. —*Staff*



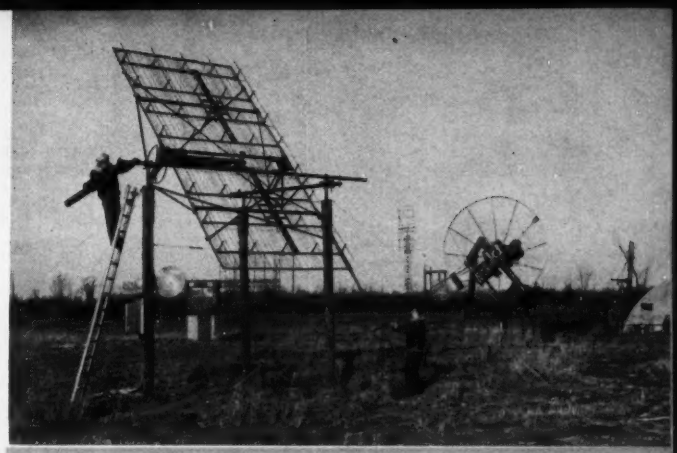
As at many other universities and colleges throughout the country, research at Cornell has, within recent year, experienced a significant increase in stature and importance.

Some verification of this trend lies in the fact that during the fiscal year 1950-1951 the dollar volume representing total research at Cornell rose from $9,500,000 to $11,500,000

This easily leads one to suspect that perhaps the seriousness of the present national emergency has prompted the government to increase financial support of research for the military. However, in Dr. T. P. Wright's 1951 Annual Report of the Vice President for Research to the President and Board of Trustees, it was stated that ". . . we have ample evidence to indicate that the increase stems in large measure from a healthy growth rather than from concentration of research monies on military or quasi-military projects."

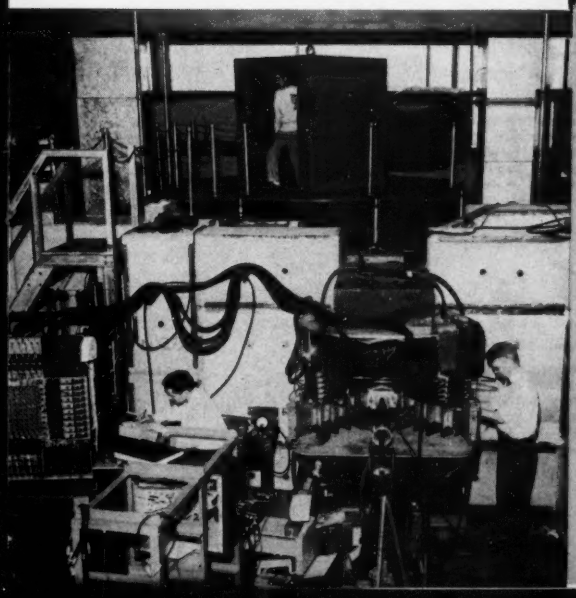
To date, Cornell has been able to refrain from performing "classified" research projects on the campus, and the University hopes that the pressures of war and war economy will not force it to abandon this policy.

These pages are intended to present a brief pictorial summary of the more important research projects associated with engineering and representing some of the most advanced thinking of Cornell's research staff.



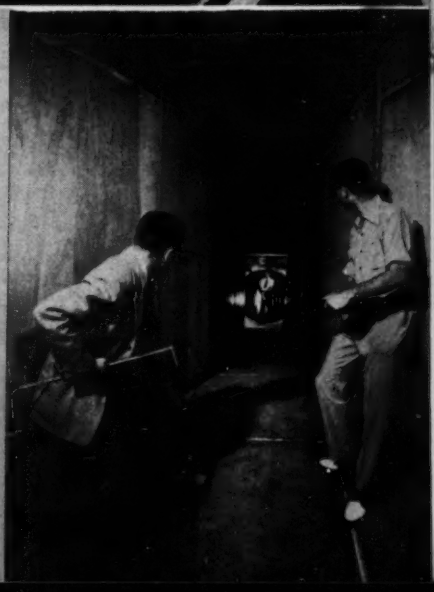
Photograph of a modified radar antenna mount being used for research in radio signals reaching the earth from outer space.
—Photo Science

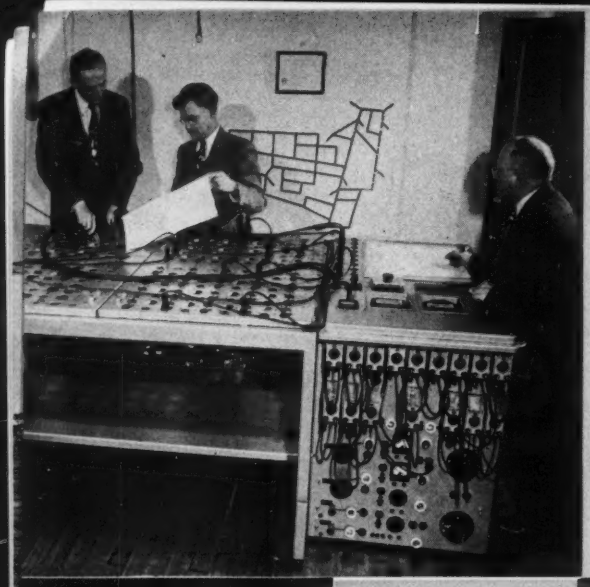
A low-temperature starting test being performed on an engine at the Cornell Aeronautical Laboratory.
—C.A.L.



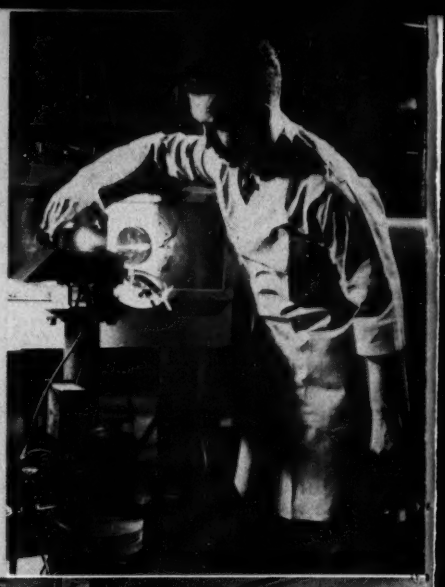
***Left*: One of Cornell's most powerful research tools, its new 300 M.E.V. synchrotron.**
—Photo Science

***Right*: This recently constructed 85 foot low speed wind tunnel is being used in an N.A.C.A.-sponsored study of the turbulent boundary layer.**
—Photo Science





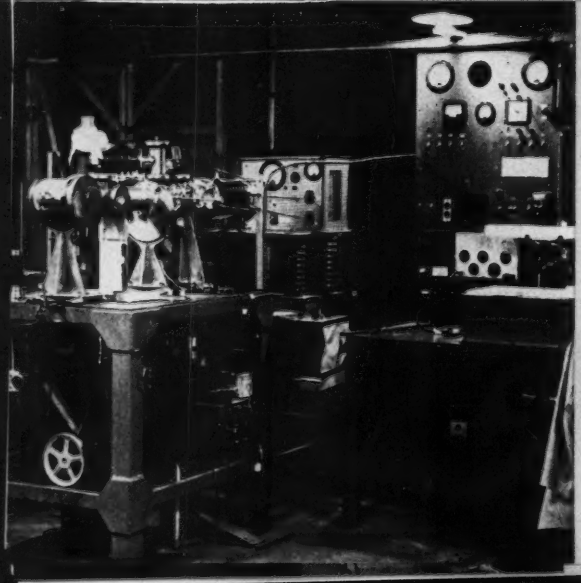
Left: Cornell's electrical pipeline-network analyzer won for its creator, Prof. M. S. Mellroy (left), the John Goodell Prize for 1950.
—*Photo Science*



Right: This schlieren optical system is an important part of the investigations into aerodynamic heating and cooling being performed at the Cornell Aeronautical Lab.
—*C.A.L.*

Left: Prevailing weather conditions may be deduced from studies of beach erosion being made with the help of models like this.
—*Courtesy D. J. Belcher*

Right: Associate Prof. G. B. DuBois (right, standing) has been directing members of the Machine Design Department in a study of lubricated journal bearings.
—*Photo Science*



Left: This electron diffraction unit has facilitated over fifteen new structure determinations during the chemistry department's current investigations of molecular structure.
—*Staff*

Right: The engineering characteristics of soil may be determined from aerial photos such as this, as a result of research by the School of Civil Engineering.
—*C.U. Air Photo*

The Rural Radio Network

By LARRY O. WEINGART, Arts '52

New Venture in Communications Provides Entertainment in Remote Areas

"With its unique FM broadcasting facilities, the Rural Radio Network is able to switch easily and quickly from point to point across the state. Hear this system in operation on the Weather Roundups." These words, heard daily all over New York State and in parts of New England and Northern Pennsylvania, give a hint of what the Rural Radio Network is—the first all-radio-relay network in the world. The network was financed, and is now owned by agricultural interests which wanted to provide radio reception in rural areas of the state free of fading, static, or interference. Those requirements, plus the lack of open spots in the AM broadcast spectrum, made the engineers decide on a series of FM stations. They further decided that since the most efficient transmitter sites with respect to coverage area would be pretty remote from telephone company long-lines facilities (which has been almost the only way of connecting two or more radio stations into a network) and that installation of phone lines to such sites would be prohibitatively expensive, these transmitter sites should be so chosen that they were within receiving distance of those stations to either side of them in the net. The end result of this planning has been that RRN has been operating since June of 1948 without the permanent rental of long distance phone lines, a savings reflected in their low operating expenses.

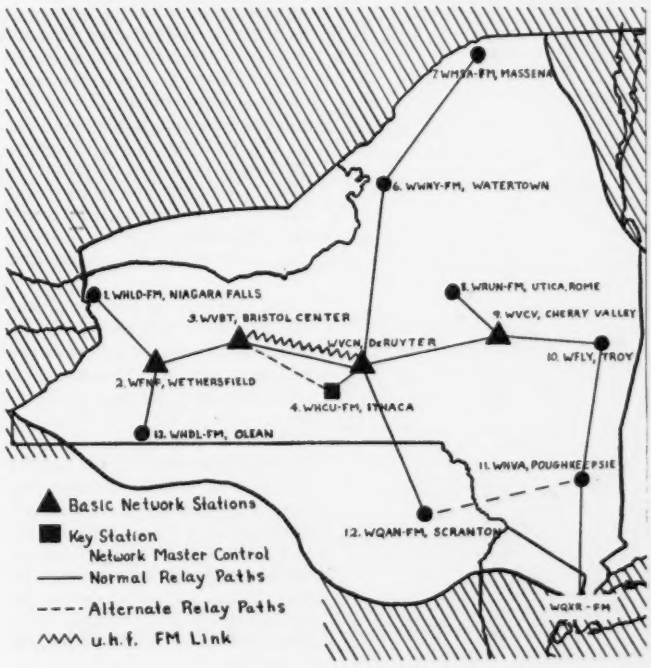
Each station in RRN is equipped with a high-gain, directional receiving antenna and a fixed frequency FM relay receiver for reception of the stations to either side of it (usually two) from which it will have to receive a program for rebroadcast. For example, WHCU-FM in Ithaca has two such receiver arrays, one for WVBT, Bristol Center, the other for WVCN, DeRuyter.

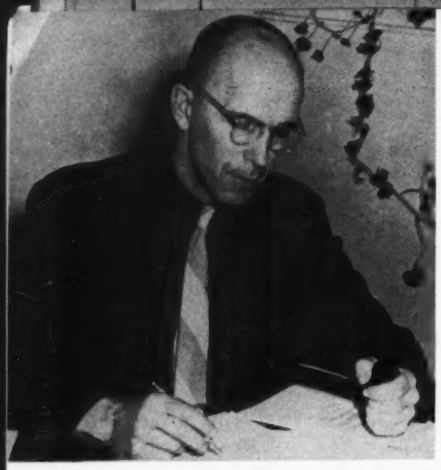
The overall system might be compared to a series circuit; if one station goes off the air, the circuit beyond it with respect to the originating station is broken and another path must be chosen to get around the break or another program must be originated by one of the stations in the broken-off portion of the net. One exception to this is the link between WVCN and WVBT. They have an ultra-high frequency FM link using highly directional beam transmission, as opposed to FM broadcast transmission, which is essentially omni-directional in the horizontal plane. If WVCN's broadcast transmitter fails, or fails to carry across the nearly 90 miles, the uhf link can be used. There are other emergency methods used which will be mentioned later.

The series circuit has one other noticeable disadvantage; at the end of each program, the originating station gives the network cue, "this is the Rural Radio Network", as a signal for each station to cut its pickup of the next station and give its own call letters as required by

(*Continued on page* 24)

A map of the Rural Radio Network showing the interrelationships between stations.





Faculty Profiles

Professor George R. Hanselman

By WALTER JONES, EP '55

Junior C.E.'s and sophomore E.E.'s at Cornell find among their required courses one labeled, "3231; Principles of Industrial Accounting and Cost Finding." To an engineer interested in strains, forces, and fields, accounting often seems a waste of time. Many enter it expecting a dull prof lecturing on routine, boring material. Whether or not they feel the same about the material, they leave this course with respect for the man who teaches it. "He's a good guy, one of the few up there," says one. "In all the time I took the course, I never saw him blow up," adds another. Most everyone agrees, "Hanselman is a good Joe."

Professor George R. Hanselman is not the type to "blow up." He is a quiet man, not of imposing physical stature and has a slim build. A receding hairline testifies that he is no longer a young man. But while he is quiet when talking to you, he possesses a great deal of self-assurance. He is confident of himself, and at the same time gives confidence to the student who comes to see him. That student like as not will find him, not at his desk, but working on scores of papers spread the length of a long table in his office. Professor Hanselman will meet his caller with a cheerful greeting and a firm (but not a politician's) handshake if it is the first visit.

The visit may concern one of several things. In addition to the one course he teaches now (before the war he taught several others), he also holds down the post of Assistant Director of the Sibley School of Mechanical Engineering. He is in charge of programming, and handles the admission of all transfer students and students with advanced standing. This brings him in contact with a good many students, but not so many as his other role, that of class advisor to one-half of the freshman M.E.'s. These students will never study under him for the one course he teaches is for students outside his school.

A large part of Professor Hanselman's life has centered around Cornell. He came here after the First World War to study Mechanical Engineering, graduating in the class of '22. He did not intend to teach at the time, nor did he decide to until almost a decade later. He worked for Goodyear Rubber and the American Creosote Company, as well as the American Locomotive Company. After the start of the depression he was offered a position at Cornell teaching accounting, which he accepted. Soon after this, the Department of Industrial and Engineering Administration was founded. Through the recommendation of faculty members, Professor Hanselman, together with Professors Bangs and Garrett, was chosen to start the new department. While continuing with his work on the faculty, he also pursued further studies. He received his masters degree in 1936 with a major in accounting and a minor in law. For three years he continued part-time study in the Law School, so as to be able to teach business law. He also wrote or helped to write a large share of his textbooks during this period. He wrote *Cases on Business Law*, based largely on his graduate thesis, and with Professor Bangs wrote *Principles of Accounting* and an accompanying problem book.

This continued until 1943, when the Navy inaugurated its V-12 program at Cornell. From then on until the end of the war Professor Hanselman led a program of accounting courses for people engaged in near-by industries. In 1946 he received the Assistant Directorship of the M.E. School, in addition to which he is now Secretary for the Sibley faculty.

Away from campus, Professor Hanselman leads a quiet life with his wife, to whom he was married in

(*Continued on page* 32)

CONFERENCE IN THE CLOUDS

Among the undergraduates on any college campus, you'll find the talk reaching up to the clouds. And once in a while – in a classroom, around a study table, or even in a bull session – a really big idea is born.

Big ideas come, too, from the men and women in laboratories, business offices, shops. But often these professionals are exploring a path first glimpsed in college.

How do we know? Because of the many college people who have come into the Bell System, where big ideas and a lot of dreams have taken their place in progress. The human voice, carried along a wire, first across a town, then a state, a nation, and now the world. Music and pictures and things happening delivered into cities and hamlets all across the land by radio and television networks.

We're always looking for the men and women who get big ideas – whether they're about people, or machines, or ways of doing things. It's the only way the Bell System can keep on giving this country the best telephone service in the world.

BELL TELEPHONE SYSTEM

News of the College

Portrait of Dean Kimball

The Dexter S. Kimball materials processing laboratory will be adorned by a portrait of Professor Kimball which is now being completed by Thomas E. Stephens of New York.

Professor Kimball is the retired dean of the College of Engineering and former president of the American Society of Mechanical Engineers and the Society for the Promotion of Engineering Education. He joined the Cornell faculty in 1898 after graduating from Stanford University, and has been associated with the University ever since. When the individual colleges of engineering were reorganized in 1920 and became the College of Engineering, he was elected the first dean—a position which he held until his retirement in 1936.

The portrait is a gift of Cornell alumnus and trustee Walker Cisler, president of Detroit Edison Co. The artist, Mr. Stephens, is known for his paintings of the five senior leaders of World War II.

Dean Emeritus Kimball being painted by Thomas E. Stephens. The portrait will be placed in Kimball Hall, now under construction.

McIlroy Appointed

The appointment of Professor Malcolm S. McIlroy as assistant director of the School of Electrical Engineering at Cornell University was announced early last month by President Deane W. Malott.

Professor McIlroy was graduated from the electrical engineering course at Cornell in 1923 and received the doctor of science degree at M.I.T. in 1947.

He has been a member of the Cornell faculty since 1947 and was awarded the John M. Goodell Prize of the American Water Works Association last year for his work in developing an electrical apparatus to study pressure flows in pipeline networks.

Professor McIlroy

Before joining the Cornell staff, he was with the General Electric Company and the Central Hudson Gas and Electric Corporation. He also taught at M.I.T., where he was assistant director of the institution's radar school during the war.

Engineers Lounge

Kappa Tau Chi, honorary mechanical engineering society, has taken over the management of the Engineers Lounge in Sibley. Among their projects for the revamping of the lounge is the construction of a magazine rack.

As an annual project in recent years, Kappa Tau Chi has sponsored a questionnaire which is distributed to all the M.E. classes in the hope that through constructive suggestions from students various aspects of the curriculum may be improved. This year they have revised the questionnaire in the hope of obtaining more productive suggestions.

GIGANTIC

NEW HYPERSORBER

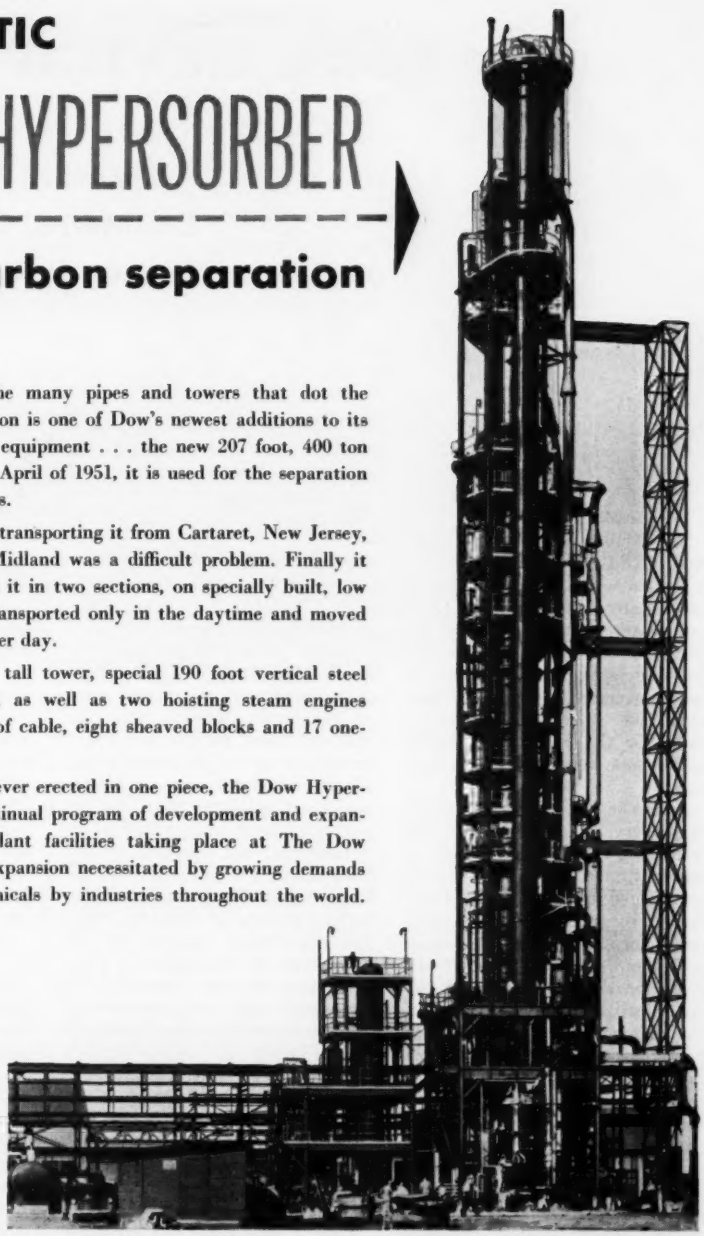
for hydrocarbon separation

Towering high above the many pipes and towers that dot the Midland, Michigan horizon is one of Dow's newest additions to its vast supply of technical equipment . . . the new 207 foot, 400 ton Hypersorber. Erected in April of 1951, it is used for the separation of light hydrocarbon gases.

Because of its huge size, transporting it from Cartaret, New Jersey, where it was made, to Midland was a difficult problem. Finally it was decided to transport it in two sections, on specially built, low slung rail cars. It was transported only in the daytime and moved no more than 100 miles per day.

For the erection of this tall tower, special 190 foot vertical steel columns were employed, as well as two hoisting steam engines controlling ¾ of a mile of cable, eight sheaved blocks and 17 one-inch cables.

The largest single drum ever erected in one piece, the Dow Hypersorber is part of the continual program of development and expansion of technical and plant facilities taking place at The Dow Chemical Company . . . expansion necessitated by growing demands for its high quality chemicals by industries throughout the world.



Dow's booklet, "Opportunities with The Dow Chemical Company," especially written for those about to enter the chemical profession, is available free, upon request. Write to The Dow Chemical Company, Technical Employment, Midland, Michigan.

THE DOW CHEMICAL COMPANY

Midland, Michigan

DOW
CHEMICALS
INDISPENSABLE TO INDUSTRY AND AGRICULTURE

BOOK REVIEW

A Standard Text On Internal Combustion Engines Is Revised

INTERNAL COMBUSTION ENGINES, *by Lester C. Lichty. Sixth Edition. McGraw Hill Book Company, Incorporated, New York,* 1950.

The present edition of INTERNAL COMBUSTION ENGINES is written with the same skill that has endeared this book to engine enthusiasts since 1915. The informed reader recognizes the author's enviable grasp of the subject and appreciation for detail without which the problems and achievements in the combustion engine field cannot be explained or understood.

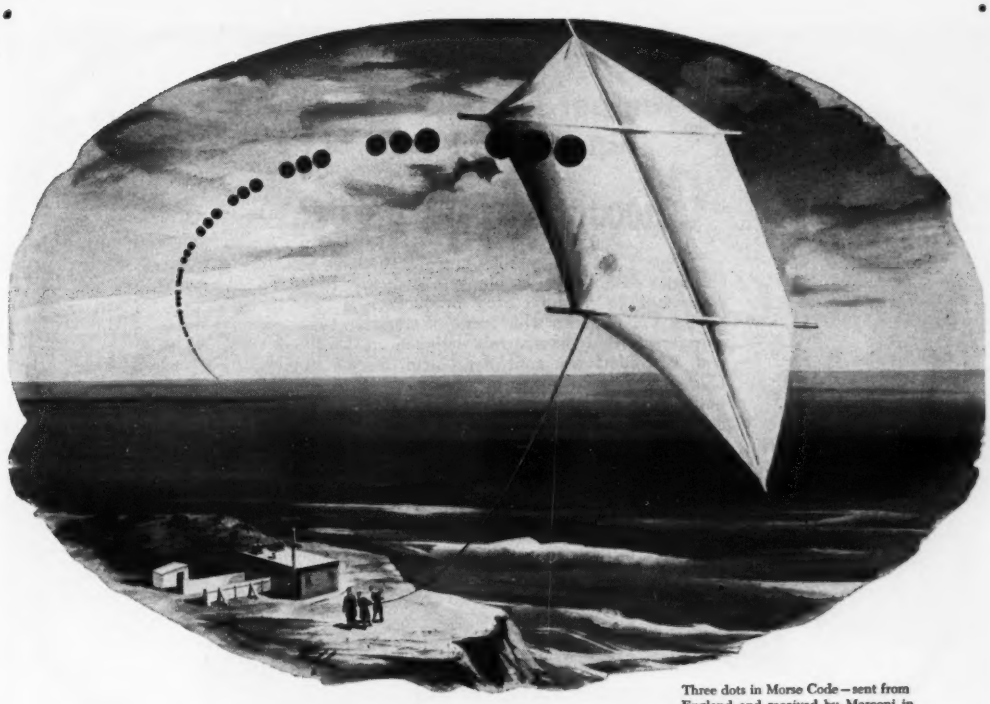
As in the earlier editions, practically every aspect of piston engine technology is either covered or touched upon. Separate chapters are devoted to the principles of pertinent thermodynamics, combustion theory, ideal cycles and engine processes, deviations from the ideal cycles, fuels, combustion knock rating of fuels, fuel carburetion and injection, manifold design criteria and mixture distribution, valve systems, spark ignition systems, combustion chamber design criteria, lubrication, cooling, performance, engine dynamics, and engine design procedures. Mention is also made of gas turbines, pulse jets, ram jets and rockets; but aside from interesting thermodynamic analyses related to the cycles of these devices, the treatment is superficial.

The strength of this book lies in Professor Lichty's admirable discussions of fuels, combustion knock, carburetion and fuel injection, manifolding and mixture distribution, valve systems, combustion chambers, lubrication, cooling, performance and engine dynamics. There is proper balance between theory and practice and many curves are used to illustrate significant points in the text. There are also some new ideas arising from Professor Lichty's active participation in combustion engine developments and his efforts to be up-to-date. For example, he makes a proper distinction between combustion knock and detonation. This is consistent with the current views of enlightened thinkers upon the matters. These persons now define detonation as the phenomenon and effects associated with a self-sustaining shock-wave front, fed by energy released during chemical reactions that are triggered by the wave front as it moves through the combustible charge at speeds up to and perhaps in excess of 20,000 fps. Combustion knock is not defined, but the impression is given that, although the phenomenon of detonation may be involved, the noise and power loss associated with severe knock stem largely from effects due to a marked inconsistency between the rates of energy release during the explosion period and the engine's ability to cope immediately with that energy, either through conversion into indicated work, dissociation of combustion products, heat losses to the coolant or gas blow-by into pistons.

The treatment of thermodynamics and the ideal cycles is good, but should not the reader understand these before undertaking the study of internal combustion engines on the level that this book aspires to? Yet, while real-mixture cycle analyses, with the use of thermodynamic charts, properly fall within the province of this book, the coverage of that topic seems insufficient. Of course, the reader can refer to the appropriate SAE Transactions and NACA Technical Notes where first hand instruction in the use of thermodynamic charts is given. The burned-mixture parts of the earlier "combustion charts" for air-octane mixtures by Hersey, Eberhardt and Hottel are again reproduced in somewhat modified form, but conveniently enlarged. However, the corresponding modified air charts are replaced by an allegedly simpler "compression chart." This seems like a forward step until one tries to use it; then comes the sobering realization that many advantages of the original modified air charts are gone.

Although its simplified approach to the subject may mislead some people into thinking otherwise, this book is not for those who seek a casual acquaintance with engines. Nor is it suitable for use as a classroom text by indifferent teachers who require that their students dig all for themselves. This book presupposes readers with considerable background in combustion engines. There is a great deal of technical content; undoubtedly, too much to suit anyone's taste. Considering that the purpose of this book is to give its readers a real insight to the art and science of modern piston engine technology, this reviewer believes that Professor Lichty has achieved that purpose.

I. Katz
Associate Professor of Mechanical Engineering



Three dots in Morse Code—sent from England and received by Marconi in Newfoundland—proved that wireless signals could span the Atlantic.

Three dots that opened a new era!

When Marconi, on December 12, 1901, heard a "3-dot" radio signal—the letter "S" in Morse Code—across 1,800 miles of sea, it was an experimental triumph that opened a new era in communications.

Before this historic event, wireless telegraphy had been limited primarily to communications between the shore and ships at sea. Marconi's success, however, was the forerunner of many other developments which led eventually to RCA world-wide radiotelegraph service that now operates more than 80 direct circuits to 67 countries.

As radio progressed, its usefulness was expanded by invention and development of the electron tube, the harnessing of short waves which made world-wide transmission a reality, and the automatic transmission and reception of messages at high speed.

Radio, with its magic of spoken words and music broadcast over the world . . . *television*, the miracle of pictures in motion transmitted through the air . . . these mediums of modern communications have added notable links in the chain of electronic advances first forged in 1901 from the mere sound of three dots.

• • •

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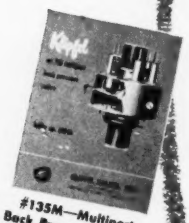


#135M—Multiport Back Pressure Valves

Progress in Petroleum

(*Continued from page* 9)

of quality. Will a minor surface defect correct itself and wear smooth; or depending upon the stress location, will the bearing burn out or cylinder wall score? Hundreds of agents have been patented with contribution to the former behavior in mind, but much of the fundamental work remains yet to be done. The kind of metal and its surface finish also affects the action of anti-seizure agents. Their acidic properties and consequently their ability to attack metals slightly provides the high bond of film strength which permits the maintenance of lubrication in the face of conditions under which ordinary lubricants fail.

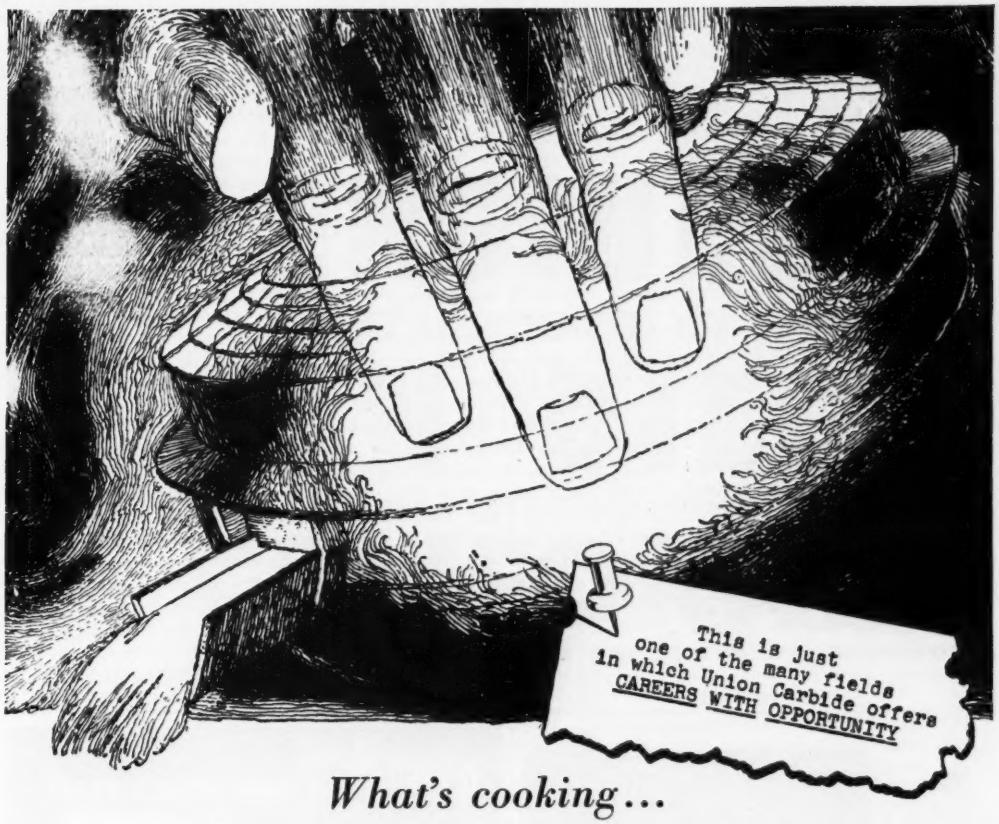
The resistance of an oil to oxidation is not assured by the mere removal of unstable material. Oil stabilization is best achieved by preventing the formation of the oxidation catalysts themselves. This complex picture has not yet been completely resolved, although many effective additives are known. The stability of an oil is also often improved by the presence of a corrosion-inhibitor for metals. The corrosion-inhibitor is added for its own sake, but in passivating a metal by molecular film the catalytic oxidizing powers of the metals are restrained.

The mechanisms of detergent action vary greatly among effective additives. One of the more common functions is that of a dispersant which prevents solid impurities from agglomerating and forming sludge residues. The net effect is that of maintaining a clean engine and obtaining a dirty oil, although actually the oil can be kept clean with the use of a filter.

Most of these additives have commonly been added to oils for only the past few years, and the field is still so new that complete revisions of theory and practices are commonplace. There is good assurance that they will contribute increasingly toward extended periods of trouble-free engine operation.

Technological progress for many other petroleum refining operations would support the observation that transitions in this industry are rapid and continuing. Even sulfuric acid manufacture has been affected. Until recently the petroleum industry has been a major consumer of sulfuric acid for its refining operations. With the current shortage of sulfur, the industry, by installing sulfur-recovery units, has become a net producer of sulfur.

A final interesting observation is the increasing use of petroleum and natural gas in the chemical industry. The present-day figure that about twenty-five per cent of all chemicals are derived from these materials shows every sign of becoming hopelessly out of date within five years. Yet this represents less than one per cent of the total production by the petroleum industry. Petroleum companies have nonetheless maintained a close interest in the chemical industry and are extensively entering into the manufacture of chemicals from petroleum.



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Rural Radio Network

(*Continued from page* 13)

the FCC. If the control engineer at any station forgets to cut that feed, the listeners to that station hear the station identification of the feeding station. To be explicit, if you hear a WVCN, DeRuyter station break while listening to WHCU-FM, someone was asleep at the switch here in Ithaca. One other minor disadvantage is that feedback, usually a high-pitched howl, can occur if a station should try to get feed from another station which is getting feed from it. But these disadvantages are all minor when considered alongside of the economy and flexibility of RRN. To make this clear, see what's involved in a phone-line network.

If a circuit analogy is to be made for phone-line networks such as CBS or NBC, it would be a circuit of components in parallel. The Master Control for the network feeds a signal into a cross-country or regional trunk line and each station is bridged across that line. A station in a wire network can cut out of network without disturbing any of the other stations. Such a system is flexible within the limitation that only one point can originate programs for the network. The reason for this is inherent in any transmission of energy; it attenuates and must be boosted at intervals to keep it up at a usable level. On long-distance phone lines used for radio networks, these boosters amplifiers are unilinear, passing and amplifying signals in one direction only. (They have other limitations also, to be mentioned later.) If the point of origin is to be switched from New York City to San Francisco during a news program, the boosters located every few hundred miles along the cross country trunk must be reversed to feed from West to East and the reversal must be done by phone company personnel. You may have noticed the 5 second pause after a switch cue is given, to reverse the boosters. In a sense, RRN uses the same system with stations which broadcast for home reception, serving as boosters as well. One important difference lies in the control of the reversal switches. A wire network must notify the phone company in advance of any network reversal; RRN can reverse its feed just as soon as a switch cue is given, with no advance warning. And—a minor point—RRN control engineers have switching time down to only 3 seconds! If it's occurred to you that one program on a wire network may come from New York and the next from Hollywood with no noticeable pause, you might also remember that you don't hear anything from the network for 15 seconds before each program; the long-lines people have ample time to reverse the network.

As a sidelight, wire networks have other methods they can use for picking up from a new point of origination. They can have a special line installed from a new point to Master Control which can be fed instantantly into the regular network line. The cost of this method

(*Continued on page* 26)

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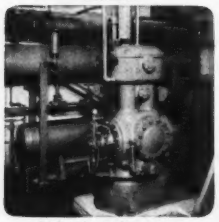

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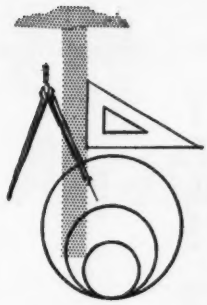

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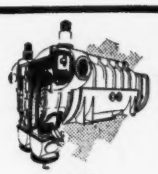

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Rural Radio Network

(*Continued from page* 24)

restricts its use to short distances; apparently it's cheaper to reverse a cross-country trunk which is being paid for than to rent a new line. Consider also that the bulk of network programs heard here in the East originate in New York. Another alternative is the "round-robin" hookup, such that a program originating at one station will travel to each other station once and finally back to the point of origin, forming a complete but not closed circle. If the circle were closed, feedback might result, followed by other howls, non-electrical in nature. The round-robin is seldom used; it's more flexible and more subject to error than is necessary.

RRN, by operating via Frequency Modulation rather than the usual AM system, is able to employ its radio relay system with its resultant economy. But it gains in many other ways by using FM. As you can see from the map of RRN, its coverage extends over all of New York State; a signal of 50 microvolts per meter is sufficient to give perfect operation of any FM receiver with an outdoor antenna. And by perfect reception is meant noise-free, and fading-free. In addition, two adjacent FM stations (separated only 0.2 mc.) will not cause a jumble on your set if the station you wish to hear delivers a signal at your set only twice as strong as the other station; this is opposed to AM where a signal ratio (seldom attained) of 1000:1 is needed.

Superior Fidelity

The final and most valuable asset of FM is its superior fidelity or reproduction, when the receiving set is of sufficient quality to make use of it. The "average" frequency response of the human ear, we are told, includes a range of about 30 to 15,000 cycles per second. The FCC requires, as minimum frequency response of an AM station from microphone amplifier through the transmitting antenna, 50 to 5000 cps with maximum deviation of 2 decibels from the reference level at 100 cps. That minimum technical bandwidth is close to the maximum legal bandwidth, for a greater frequency range would require a transmission bandwidth greater than the 10 kilocycles allowed for AM. If AM stations were to operate with a wider bandwidth, fewer stations could be accomodated within the already crowded AM spectrum of 540 to 1600 kc. In contrast, the minimum requirements of the FCC for an FM station include a frequency response (excluding the preemphasis of frequencies over 100 cps which is balanced off by an equal deemphasis in receivers) essentially flat from 50 to 15,000 cps. The obvious advantage of FM over AM for accurate reproduction becomes ever more obvious when the quality of home receivers is taken into account. The average AM receiver has an even narrower frequency response than the transmitter, while most FM receivers (of the limiter-discriminator type—

(*Continued on page* 28)

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HERCULES

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Rural Radio Network

(*Continued from page 26*)

the Foster-Seeley circuit) will deliver the full bandwidth transmitted on FM; the greater fidelity becomes apparent if the signal is properly amplified and fed through a good loudspeaker.

RRN's radio relay system becomes even more valuable in this context. The limiting factor in the long-distance transmission of audio signals via phone lines is the booster amplifier. The CBS network line between New York City and WHCU-AM has a frequency response of approximately 80 to 6000 cps, wide enough for AM transmission but very deficient for FM transmission of anything other than speech. Better boosters can be provided (in fact, there is an FM network using phone lines with 20 to 20,000 cps response, the Continental FM Network), but at a higher cost from the phone company. And radio relay provides equal performance with less cost than the usual radio phone lines. It's interesting to note that RRN's overall frequency response, from WHVA in Poughkeepsie through to WHLD in Niagara Falls, is essentially flat from 30 to 18,000 cps, with less than 1% distortion and a signal-to-noise ratio of better than 60 db. (That is, noise intensity is on the order of 0.001 of signal intensity, the noise being composed of such things as amplifier tube hiss, etc.) The final proof of this superb reproduction is that the difference between live performances and recordings of music from New York is distinctly noticeable, even without the tip-off surface noise on the records!

Five Radio Stations

Now, knowing how RRN operates and how its operation compares with standard AM operation, perhaps you'd like to know some facts and figures about the network before going on to what is, after all, most important in radio—the programs it presents. The basic network includes five stations, four owned by the Rural Radio Foundation, and the fifth, WHCU-FM, owned by Cornell University. Each of the four operates with an effective radiated power of 5.4 kilowatts (effective radiated power or e.r.p., because the radiation, though horizontally omnidirectional, is confined to a very narrow vertical angle, and the power emitted by a smaller transmitter, but directed by this pattern, is equal to the power that would be emitted by a completely non-directional transmitter of the stated magnitude.) WHCU-FM is 40 kw. e.r.p., which is both a curse and a blessing. The curse arises from the effect of 40 kw. bouncing off different hills in the Ithaca area and arriving at a receiver in many and various phase relationships. The total efffect of this "multipath reception" is distortion, particularly noticeable on low-frequency sounds. The blessing of 40 kw. becomes appreciable when you're told that, for a time in the summer of '51 when WVCV in Cherry Valley was unable to receive WVCN because of receiver difficulties, it was able to pick up a usable signal from WHCU-FM, 100 miles away! That was one of the emergency methods of getting around a break in the "series circuit," receiving the key station directly. That "key station" label applied to WHCU-FM refers to the fact that it originates about 10 of the 16 broadcast hours per weekday on RRN. And, having raised that point, it's appropriate to turn to the programming of RRN.

Original Plan

The original intent behind the foundation of RRN was that of providing services for farmers not easily available elsewhere. Accordingly, a good part of RRN's time is devoted to material of specific interest and value to farmers—the latest livestock and produce market reports as received in Ithaca via private teletype and via news services, farm news and developments, and agricultural weather advice. This last includes long range forecasts by the U. S. Weather Bureau, specific advice about certain crops in season, area forecasts more specific than provided elsewhere, and finally, reports from each station of weather conditions at that time, which gives areas to

(*Continued on page 30*)

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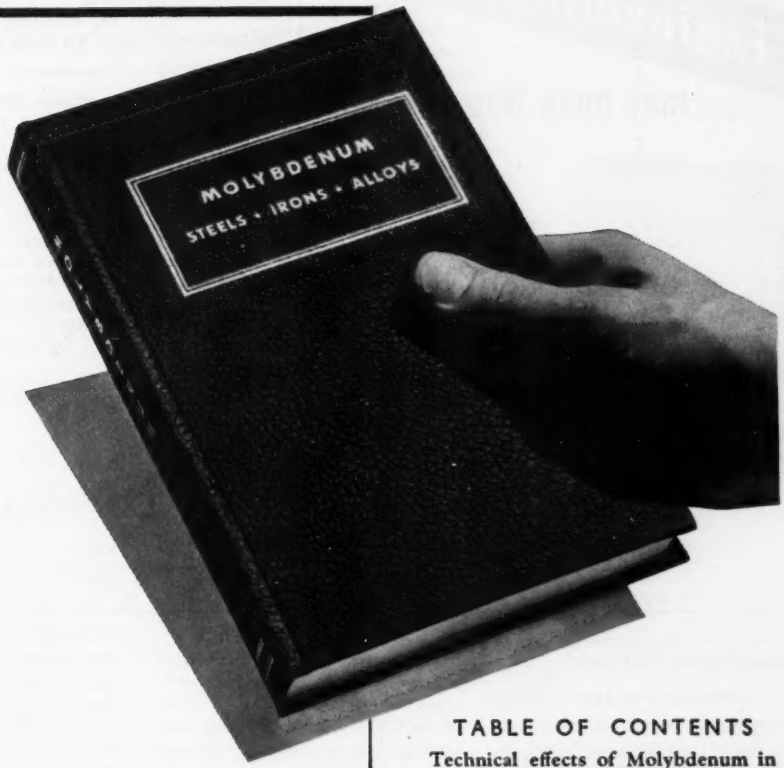

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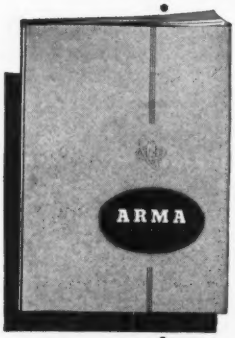

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THE CORNELL CO-OP

Barnes Hall — On The Campus

Rural Radio Network

(*Continued from page* 28)

the East of a reporting station an idea of what to expect and when. These weather roundups are broadcast five times each day, excluding Sunday. And for those people in Ithaca who don't have FM sets, WHCU-AM broadcasts one of the weather roundups at about 7:30 a.m. These farm features do not fill a 16 hour broadcast day, however. Neither do they provide very much entertainment value (excluding the 6:35 and 7:15 a.m. weather roundups which sometimes bear striking resemblances to a rodeo with all the horsing around). RRN, as did most FM stations, discovered that few people would tune to FM unless what they got was better than what was on AM. And RRN found that farmers and farmers' wives and families like the same sort of entertainment that urban dwellers do, after their information needs have been satisfied.

In the summer of 1950, RRN experimented with rebroadcasting serious music programs and newscasts from WQXR-FM in New York City, outside of their farm service hours. Listener response was overwhelmingly in favor of the move and it certainly was in keeping with the advantages in fidelity of FM relay operation. Therefore RRN decided to continue these broadcasts. Programs from New York are carried about six hours each day to the enjoyment of many listeners, both rural and urban. In addition, eight stations have become affiliated with RRN to carry these programs and also a good portion of the information programs from Ithaca. Some interesting production problems have arisen from the rebroadcast of a station located in New York City and with a tradition of local services, quite out of place in upstate New York. As an example, WQXR gives a weather forecast at 9:28 p.m. for New York City, only slightly more useful outside of the city than the weather forecast for a minor state in Africa. The solution arrived at by RRN was the use of short selections of piano music to be played on RRN from WHVA while WQXR gives its weather forecast, or any other announcement of little interest to upstate listeners.

Others Completed

The last thing that can be mentioned about any new system like RRN is its impression on other people in its field. And that impression is favorable. Several other groups, in different parts of the United States are contemplating similar systems. The present plan for the educational TV network to be operated in New York State by the Board of Regents calls for a direct relay system equivalent to that first used by RRN. At present the empire state FM network, which includes RRN, operates with twenty FM stations for a half-hour per day to broadcast programs to New York State schools. And RRN is the main transmission line across New York State for the New

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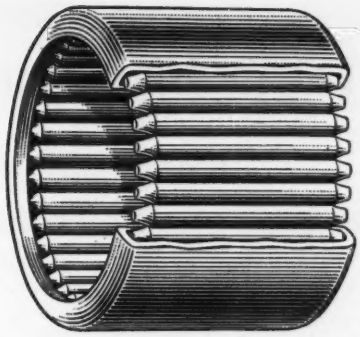

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The bearing is a complete unit in itself, and is easily pressed into position in a bore machined to proper dimensions. The advantages of this unit construction in simplifying installation and speeding assembly are readily apparent.

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Of special importance is the high capacity of the Torrington Needle Bearing. This efficient anti-friction unit can carry a greater radial load than any other bearing of comparable outside diameter due to the large number of rollers. The small cross section of the bearing allows a large shaft which permits a rigid design with minimum shaft deflection.

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Prof. G. H. Hanselman

(*Continued from page* 16)

1923. At present he has several hobbies. (Aside from learning to roll his own cigarettes, which he uses as a light-hearted cure for smoking too much.) One is gardening. Like many, he started a Victory Garden during the War. When the fighting stopped, he kept on, turning more to flowers than vegetables. His other hobby is collecting matchbooks, which began in 1933 with an interesting cover brought back from a trip to Philadelphia. His collection is large (7500 books) and broad. He makes no attempt to collect from any one particular field. The remnants of a former hobby, photography, also decorate his office. Several large frames, each holding fifteen or twenty pictures of friends or scenic views, hang on each wall. Professor Hanselman plays golf regularly during the season, though in the last few years he has had to cut a day's game from twenty-seven to eighteen holes.

He is at present active in local organizations, as he was in college organizations during his undergraduate days. At that time he was a member of Pi Kappa Phi social fraternity, and Atmos and Kappa Tau Chi, engineering societies. Recently he served one year as Director for the Binghamton Chapter of the National Association of Cost Accountants. He now holds the position in the Ithaca Rotary Club of Director in charge of work for crippled children. He has been instrumental in bringing Cornell shows and dramatic productions to the local infantile paralysis center.

Professor Hanselman will admit, when asked, that he didn't intend to make teaching a lifetime profession. Why, then, did he continue at it? Probably the best answer is his own: "One of the greatest opportunities we have at college," he says, "is the chance it gives us for contact with young people." Perhaps it is this feeling that makes a teacher such as Professor Hanselman successful.

Rural Radio Network

(*Continued from page* 30)

York Civil Defense Network.

The lasting impression on engineers is this: RRN was engineered, then built. The planning went to the extent of determining performance of FM receivers available at the time and incorporating these data into the design of the network. Donald K. DeNeuf, who was Chief Engineer of RRN during the planning and construction phase, and is now Assistant General Manager, sums it up: "On this project, the engineers were in at the start. Instead of being called upon to find a way to make the system work in spite of the way it had been set up, we took part of the initial planning. Now, with the system in operation, there is no conflict between management objectives and policies and the engineering of the system."*

**FM and Television, September* 1948, *Copyright by Milton B. Sleeper.*

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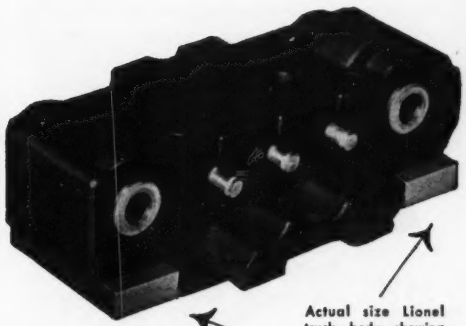
LAVA CRUCIBLE COMPANY of PITTSBURGH
Pittsburgh, Pennsylvania

What's Happening at CRUCIBLE

about permanent alnico magnets



Actual size Lionel truck body showing two Crucible alnico bar magnets in place.

Lionel uses Crucible Alnico in new locomotive design

The Lionel Corporation, big name electrical toy manufacturer, has pioneered in the design of miniature locomotives for table-top railroading. One of the principal aims of this design is to achieve the highest possible degree of adhesion between the driving wheels and the track.

Lionel experimented with a conventional method of increasing the traction (i.e. load up the driving axles with ballast weights) . . . and then turned to magnetic materials.

Crucible alnico specialists were called in. Working in close cooperation with Lionel engineers, the Lionel "Magne-Traction" locomotive was born. As the name implies, "Magne-Traction" utilizes magnetic attraction between powerful Crucible alnico bar magnets placed in close proximity with the wheels.

By varying the number and strength of the magnets, almost any desired degree of adhesion can be obtained. In laboratory tests a light-weight plastic "Scout" locomotive whose normal train load is 4 cars, was able, after installation of proper magnets, to pull a train of 24 cars, an improvement of 600%. A heavy miniature locomotive

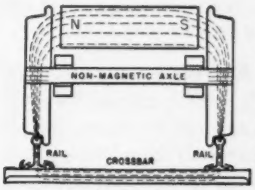


Diagram shows how magnetizing force is supplied by external stationary Crucible permanent magnet and non-magnetic axle. Wheels are sintered steel.

pulled 28 cars instead of its usual load of 7 cars. Then too, locomotives unable to start a normal 4 or 5 car train on greater than 1 degree slope were able with the special magnet assembly to pull them from a dead start up a 5° slope, while the new twin-motor Lionel Pennsy GG-1 scooted up a 15° slope (i.e. 37% grade) without any apparent difficulty.

Crucible's part was twofold. Not only were Crucible metallurgists and engineers active in the initial design, but Crucible production experts precision cast these bar magnets using plastic patterns. This is an innovation in alnico magnet mass production. Commonly, alnico is made in sand molds, and usually requires a great deal of finishing, but with precision-cast alnico magnets expensive machining is cut to a minimum.

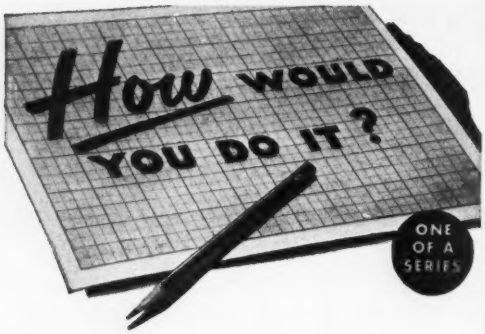
Engineering Service Available

Your permanent magnet problem will receive the same experienced consideration from Crucible's unsurpassed staff of metallurgists and production specialists. Please give full details. Crucible Steel Company of America, General Sales Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

52 *years of* Fine *steelmaking*

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin



PROBLEM—You are designing a cabinet-type oil heater. The oil and air metering valve has to be placed at the bottom. You now want to provide a manual control for the valve located on the cabinet front where it is easy to see and to operate. How would you do it?

THE SIMPLE ANSWER—Use an S.S.White remote control flexible shaft to connect the dial to the valve or to a rod running to the valve. The latter method was used in the heater illustrated below. The flexible shaft will provide smooth, sensitive control and will allow you to put the dial anywhere you want it.

Photo courtesy of Quaker Mfg. Co., Chicago, Ill.

★ ★ ★

This is just one of hundreds of power drive and remote control problems to which S.S.White flexible shafts are the simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles"* for mechanical bodies.

*Trademark Reg. U.S. Pat. Off and elsewhere

WRITE FOR BULLETIN 5008

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours free for asking. Write today.

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DENTAL MFG. CO.
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Permit Closer Running Clearances...

MORRIS HORIZONTAL SPLIT *Double-Suction*
WATER PUMP

No other pump has the Floating Sealing Rings . . . yet this exclusive feature alone makes the Morris Double-Suction Water Pump outstanding for efficiency and long service.

During the instant that the pump comes up to speed, but before full pressure is built up, the Morris Floating Sealing Rings adjust themselves to a uniformly close running clearance around the impeller. As soon as full speed is developed, the internal hydraulic pressure acting upon the vertical face of the Floating Ring, presses it tightly against the precision machined surface of the casing ring where it is firmly held in place.

This action permits machining the rings to closer clearances. Leakage is consequently reduced to a minimum, initial efficiency maintained for much longer periods of service. Assures concentricity of ring with impeller and eliminates binding due to abnormal operating conditions.

Advanced design of Morris Double-Suction Water Pumps and their several exclusive features assure increased hydraulic and mechanical efficiency . . . reliability . . . and low maintenance cost. Write today for free Bulletin 179.

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MORRIS *Centrifugal Pumps*

USE THE WORLD'S BEST at NO EXTRA COST

Begin your career by doing what the masters do . . . use CASTELL with the famous *imported* graphite. It costs no more than ordinary domestic brands.

18 superlative degrees that match every mood of genius. Ask for CASTELL 9000 at your college supply store.

AW FABER-CASTELL
PENCIL COMPANY INC. NEWARK 4, N.J.

STRESS and STRAIN...

The courtroom was crowded; tension crackled through the air. The defendent, charged with murder, sank lower and lower in the witness box, trying to avoid the gesticulating attorney. Deciding that his man was at the breaking point, the attorney screamed at him, "We've got the goods on you! You can't go free! You'd better talk turkey."

The attorney was right. The cornered man jumped to his feet, his face, his entire body, depicting the agony of a broken man. He could stand it no longer. "Gobble, gobble," he shrieked.

* * *

Judge: I'm sorry, I can't issue a marriage license until you have properly filled out that form.

Gal: Look buddy, if my boyfriend doesn't care, what business is it of yours?"

* * *

A newly married doctor was taking his young wife out for a walk when a pretty girl smiled and bowed to him.

Wife (scenting an earlier affair): "Who's the girl, dear?"

Doctor (nonchalantly): "Just a girl I've met professionally once or twice."

Wife: "No doubt—but whose profession?"

* * *

Then there was the EP who called his girl "Carbon" because her resistance went down as she warmed up.

* * *

Captain of a sinking excursion boat: "Does anyone here know how to pray?"

Engineer: "I do."

Captain: "Well you pray and the rest of us will put on life belts. We're one shy."

When her fair heart you had won
I'll bet you thought your work was done.
Permit us a little laughter,
If we tell you that hereafter
You'll have to win it twice a day
From the following array:
Ice man, gas man, telephone, super,
Who will keep you in a stupor,
For as you are working, they will be playing
In the house for which you are paying.

* * *

Husband: If there are any more additions to this family, I'll shoot myself.

Wife: Wait dear, don't shoot an innocent man.

* * *

Two old mountaineers were sitting on the front porch, examining an ancient squirrel gun.

"Good shotgun that," said the owner. "Got me possum, coon, turkey, squirrel, and rabbit for twenty years. The last year it got me two son-in-laws."

* * *

The EE's Lament

Through the smoke and ozone fumes the student slowly rises
His hair is singed, his face is black, his partner he despises.
He shakes his head and says to him, with words so softly spoken,
"The last thing that you said to me was, 'Sure, the switch is open'."

* * *

A tired C.E. arrived at home. The cook and maid had quit that morning without notice. His last bridge had just collapsed into the river, and to top everything he found a farewell message from his wife. He knew that one shot would end it all. So he opened his desk, pulled out his bottle, and took one.

First Indian: Ugh!
Second Indian: Ugh!
First Indian: Ugh!
Second Indian: Ugh Ugh!
First Indian: Don't change subject!

* * *

It is rumored that a certain EE professor is writing a book for D.C. machinery, to be called "Forever Ampere."

* * *

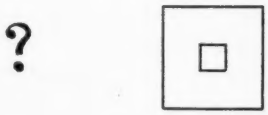
She: And what would you be, if it weren't for my money?
He: A bachelor!

* * *

The naked hills lie wanton to the breeze.
The fields are nude, the groves unfrocked,
Bare are the limbs of all the trees.
No wonder the corn is shocked.

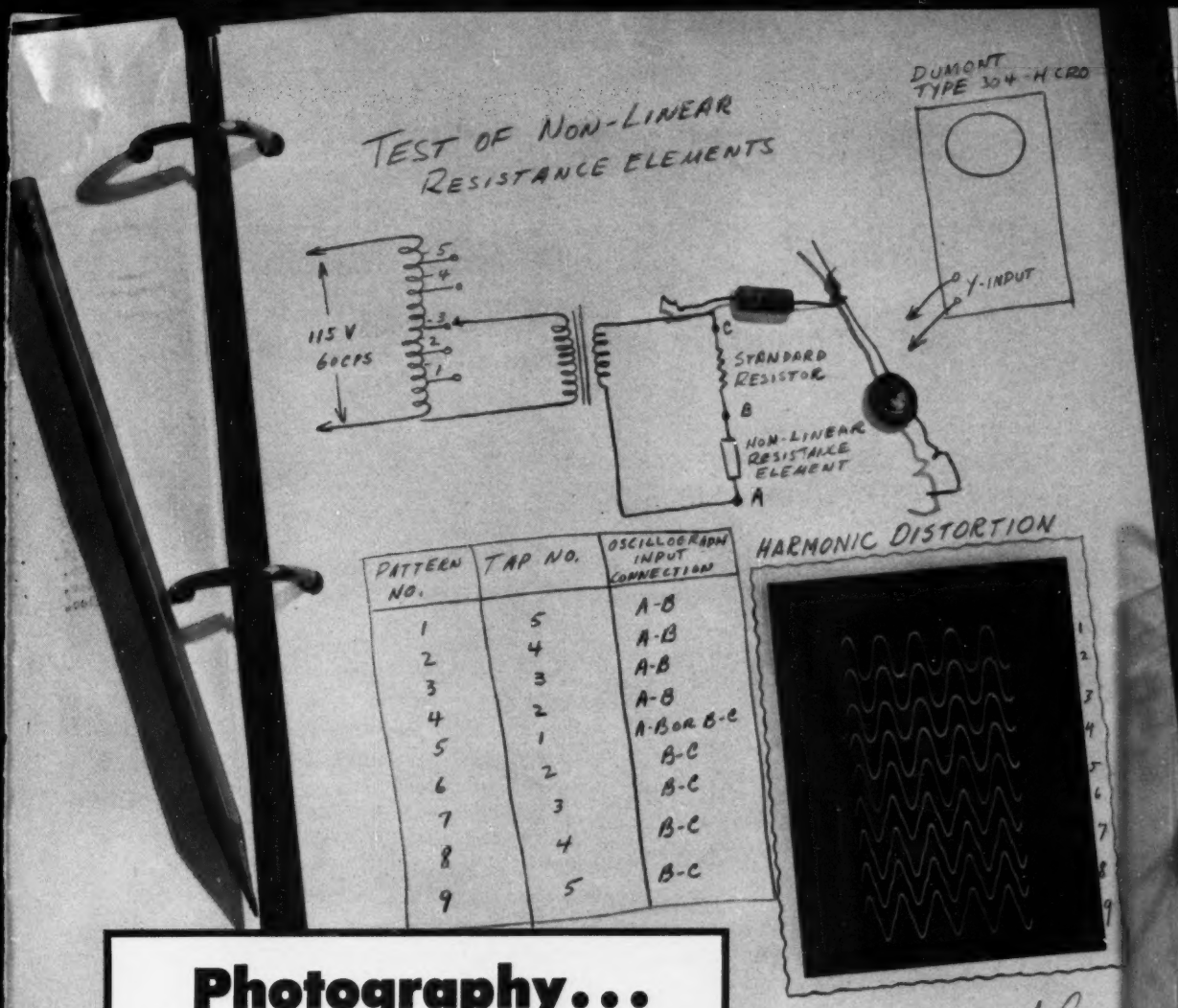
* * *

This month's brain-teaser: Draw the front view of the solid whose top and side views are shown below.



Answer to last month's brain-teaser:

9456
1072
———
10528



Photography...

the engineer's partner all along the way

• Photography proves itself an important and valuable ally all through engineering.

Its speed in copying and reproducing data saves valuable time. Its use in radiography and instrument recording improves manufacturing processes and finished products. High speed movies help solve design problems.

Applications of photography in science and industry are steadily multiplying. This has attracted graduates in the physical sciences and engineering to find positions with the Eastman Kodak Company. If you are interested, consult your placement office about arranging an interview with an Eastman representative, or write direct to Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.

FUNCTIONAL PHOTOGRAPHY

serves industrial, commercial, and scientific progress

Here photographic oscillograph traces become an indisputable part of an engineer's notes, recording the effect of a new electronic circuit element on wave form. This record of performance stands ready for new evaluation at any time.

Kodak

TRADE-MARK

We conducted a poll* of '41 graduates to find out:

HOW HAVE THEY MADE OUT IN 10 YEARS WITH GENERAL ELECTRIC?

Here are the results:

1. TRAINING. On the average, college graduates who came with General Electric in 1941 have taken between three and four Company-run training courses. Some have taken as many as seven. These have included courses in business management and accounting, in sales, manufacturing, and in many phases of engineering. Graduates report that this training has been a big help in furthering their careers. As one expressed it: "These courses are essential to certain fields of endeavor—so essential I am still signing up for additional courses."

Other comments: "These programs are not the purely academic ones of school days. They are practical, interesting, enable one to do a better job and enjoy it more." "The G-E Sales Training Program was definitely instrumental in helping me find my present position." The training programs have been a very essential link between my college training and my present work." "I wish I could have known then how valuable these courses were going to be later." "They confirmed my original opinion that G.E. offered the best training for engineers."

2. EXPERIENCE. These graduates have had an average of three different rotating assignments in various phases of the Company's work. A typical example included assignments in radio test, in motors and generators, and in the industrial control development laboratory. Graduates express three main benefits derived from the G-E rotational job programs:

a. They provided opportunities for deciding on a definite field of interest. Typical comment: "I didn't know what kind of work I wanted to do. Rotating assignments helped me make up my mind."

b. They complemented college training with practical experience. "They helped me realize methods of manufacture and testing of different apparatus."

c. They provided valuable associations and contacts. "Changing jobs five times brought me a variety of friends and contacts I'm still grateful for."

3. PROGRESS AND ADVANCEMENT. 88 per cent reported that they felt their progress in General Electric has been satisfactory. Nine per cent described their progress as "average, so-so," with three per cent reporting "unsatisfactory."

Comments: "It's been no Horatio Alger success story, but I feel pretty good about it." "If next 10 years have the same trend, will be very happy." "Satisfactory and entirely fair." "I don't know anyone on the outside who has done any better in the same time." "Satisfactory. I've been a G-E salesman, field engineer, and am now group leader in a G-E design engineering department." "I have felt like a kid in a candy story owned by his father. There are lots of choices and his only problem is to pick out what he likes best."

Facts and statements in this advertisement were compiled from a questionnaire submitted to '41 graduates still with General Electric. Participants returned questionnaires unsigned, enabling them to be full and frank in their answers.

You can put your confidence in—

GENERAL ELECTRIC